Space Weather Technical Forecast

Issued on Monday, 17 April 2023 at 12:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts), and a slight chance of X-Class flares (R3 strong radio blackouts) throughout. Chance of G1/Minor Storms 19-20 Apr with a slight chance of G2/Moderate or G3/Strong Storms on the 20 Apr due to possible CME arrival.

Analysis of Space Weather Activity over past 24 hours
Solar Activity: Solar activity has been Low through the last 24 hours, with two notable C-class flares. The first was a C9.0 flare from a region behind the northeast limb at 16/1742UTC. A C7.0 flare was then observed from AR3281 at 17/0634UTC. There are now nine sunspot regions on the visible disc, with six of these presenting various levels of a complex βγ magnetic configuration. The largest region is AR3282 in the northeast, which has evolved slowly over the last 24 hours following a previous fast development and is now an Fki Zurich classification. AR3280, approaching the southwest limb is becoming difficult to analyse due to the location. AR3279 and AR3281 are also relatively complex but stable and appear to be interacting magnetically. AR3283 to the southeast of the aforementioned regions is also starting to develop.

A CME which left the eastern limb of the Sun during 16 Apr is not forecast to affect the Earth. No further potential Earth-directed CME have been observed on available imagery in the last 24 hours.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 has mainly been at background levels, but showed a steady increase from 17/0900UTC, allied with a dip in density, suggesting a weak coronal hole high speed stream connection, possibly due to either coronal holes 92 or 93. Total magnetic field, IMF, was weak throughout much of the period, with a slight rise to moderate levels from 17/1100UTC, reaching 10nT by 17/1144UTC. The north-south component has varied weakly through much of the period, but rotated sharply southwards after 17/1130UTC, to reach -8nT. The phi angle was generally positive (towards the Sun) or near neutral. Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at background levels. High energy electron flux (greater than 2MeV) as measured at GOES16 was at background levels. The associated 24-hour integrated electron fluence was well below the Active threshold on a slowly declining trend, with 1.31e6 integrated pfu observed at 17/0000UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is expected to be Low, with a likelihood of Moderate activity, mainly due to AR3282 or AR3280. There is also a chance for significant activity from two regions beyond the eastern limb, which are starting to rotate onto the visible disc.

Solar Wind / Geomagnetic Activity: Two CMEs are forecast to affect the Earth in this period. One, as a low confidence glancing blow on 19 Apr, with a further more direct near full halo on 20 Apr. Otherwise solar winds are expected to remain mainly at background, with a possible brief rise to slightly elevated values as a result of weak coronal hole high speed streams from coronal holes 92 or 93 on 17 and 18 Apr. A further coronal hole high speed stream is possible late on 20 Apr, but this may be masked by the forecast CME arrival. Geomagnetic activity is forecast to be mainly Quiet to Unsettled, with a chance of G1/Minor Storm intervals on 19 and 20 Apr. There is also a risk of G2/Moderate or G3/Strong storms on 20 Apr depending on the strength of the CME arrival.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels, although there is a slight chance of a greater than S1 event as some of the more complex active regions transit towards the western solar hemisphere. High energy (greater than 2 MeV) electron flux is currently at background levels throughout the period. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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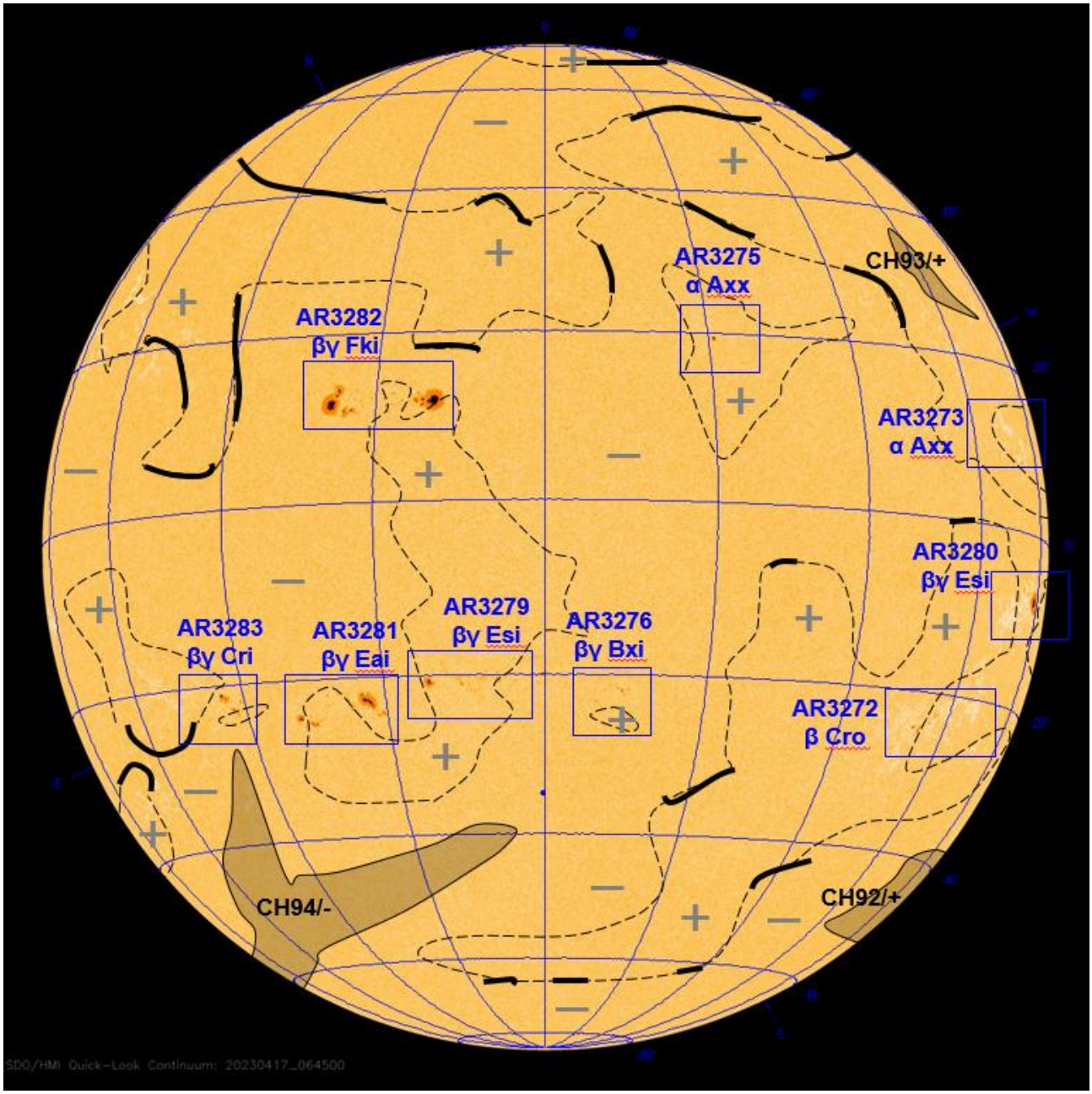
Figure 1. Solar Analysis Valid 17/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Two CMEs are forecast to have an Earth-directed component through this forecast period. The first, a filament eruption at around 15/1100UTC is forecast to potentially glance the Earth during 19 Apr. A CME halo from an eruption on 15/2324UTC is then forecast to arrive at Earth during 20 Apr, perhaps into 21 Apr. There is moderate confidence in the forecast for this eruption, with several analysis returning similar numbers. However the Enlil ensemble is currently giving a large spread centred on 20/1800UTC. Further analysis will continue to try to provide a more precise arrival window. A CME glance which was expected on 16 Apr is now assumed to have missed the Earth.

A high speed stream appeared to connect with the Earth from around 17/1100UTC, which may be a weak connection to either coronal holes 92 or 93. Speeds are currently around 400km/s on a shallow rising trend. This connection should subside by 18 Apr due to the position of the coronal holes on the visible disc. The CME forecast is potentially contaminated by a high speed stream from coronal hole which could connect with the Earth from later on 20 April, although given the high southern latitude of the feature, any connection is low confidence.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled through 17 to 19 Apr. There is then a chance of Active or G1/Minor storm intervals due to the glancing CME on 19 Apr. Further Active intervals are then likely on 20 Apr due to the CME arrival, with a chance of G1/Minor Storm intervals. The feature is currently modelled to be moving at 300-400km/s, with a slight chance of this stage of G2/Moderate or G3/Strong Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	1	1	20	40
Strong	**G3**	No	1	1	1	10
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0550	Partial halo	Filament eruption	NW quadrant	250km/s	19/1200UTC	Low confidence
16/1343	Partial halo	Filament eruption	NW quadrant	350km/s	20/1800UTC	Possible G2 or G3 storms

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Figure 2: MOSWOC Enlil showing possible arrival time of near full halo CME.

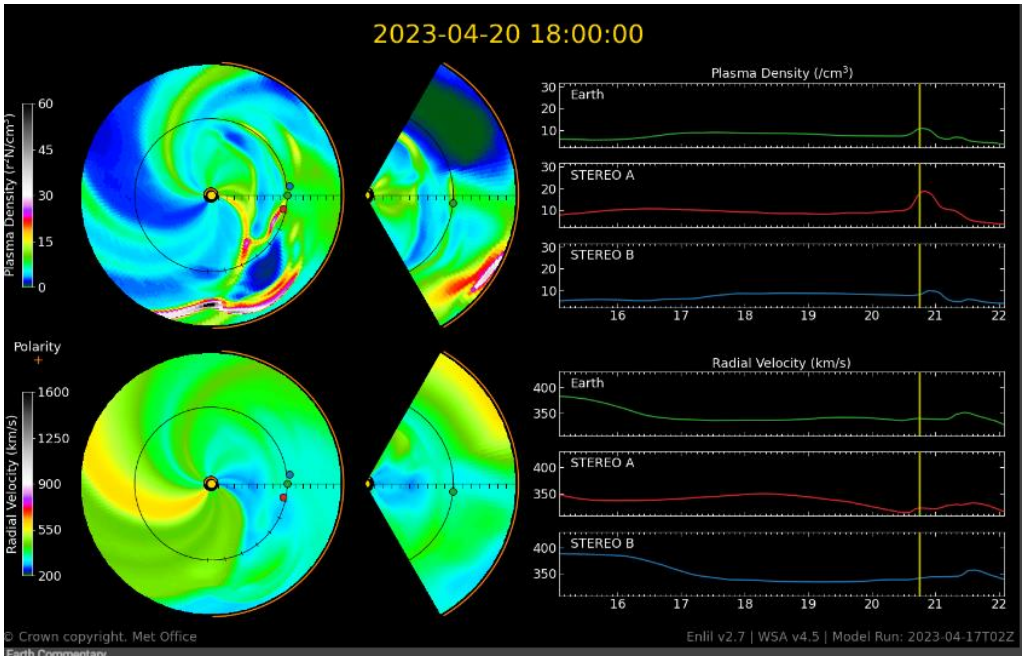
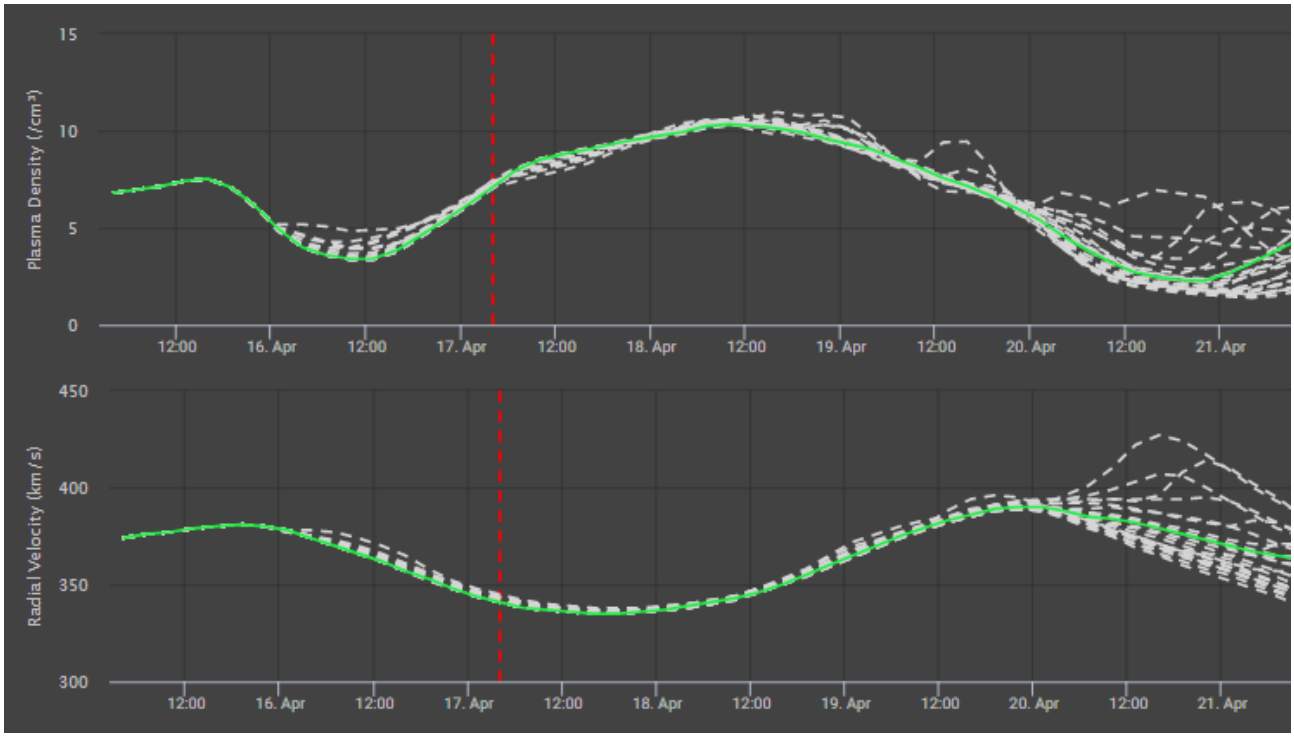


Figure 3: MOSWOC Enlil ensemble, showing the range of potential arrival times across the ensemble members for the 20 Apr CME, demonstrating moderate uncertainty in the arrival time.



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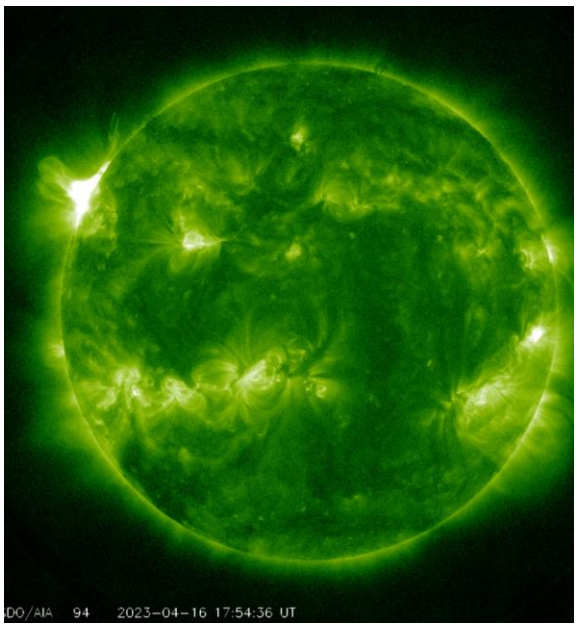
Radio Blackouts - X-Ray Flares:
There are nine active regions on the visible disc, with four large and complex, but relatively inactive regions. The highest risk region is AR3282 in the northeast quadrant which developed rapidly through a 36 hour period to the current size, but has since stabilised. AR3280 also presents a risk of significant flare activity, especially based on the southwest limb, where it could produce geoeffective proton storming from energetic storms. None of the regions have a recent history of significant activity, which is reflected on risks below those suggested by raw risk probabilities for the various configurations.

Two regions beyond the northeast and southeast limb respectively appear bright of SDO AIA 94 imagery and could reveal significant complexity as they rotate onto the visible disc. The northeast limb region already has a history of a relatively large flare, producing a C9.0 with some of this occulted by the solar limb.

Mainly Low solar activity is expected, with a likelihood of M-class flares and a very slight chance of X-class flaring.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 3: SDO/HMI 94 imagery of C9.0 flare from northeast limb of Sun on 16 Apr.



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at background levels through the period.

AR3280 carries the greatest risk of a proton event early in the period, with a continued high level of magnetic complexity as it rotates across the western hemisphere. A number of complex regions in the east could produce some proton response from particularly energetic events, with these acting to maintain the risk into the period as they rotate westward.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	5	10	10	10
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

As the solar wind is currently slow, with no high speed streams to feed electrons into the radiation belts, or solar wind pressure to suppress the belts into lower orbits the high energy electron flux (greater than 2MeV) has been at background and is expected to remain so for much of the forecast period. Enhanced geomagnetic activity due to forecast CME arrivals on 19 and 20 Apr could prolong this depression, with a gradual increase most likely beyond the end of the forecast period as the geomagnetic activity fades.

Electron fluence is expected to remain below the Active threshold due to the geomagnetic enhancements.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	1	1
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5:

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